REMARKS

I. Introduction

By the present Amendment, claims 1, 6, and 18 have been amended. Claim 5 has been cancelled. Accordingly, claims 1-4, 6, 8-10, and 18-20 are now pending in the application. Claims 1 and 18 are independent.

II. Office Action Summary

In the Office Action of November 23, 2010, claims 1-6, 8, and 18-20 were rejected under 35 USC §103(a) as being unpatentable over U.S. Patent No. 6,261,234 issued to Lin in view of U.S. Patent No. 6,045,508 issued to Hossack et al. ("Hossack"), and further in view of U.S. Patent No. 6,263,089 issued to Otsuka et al. ("Otsuka"). Claims 9 and 10 were rejected under 35 USC §103(a) as being unpatentable over Lin in view of Hossack and Otsuka, and further in view of U.S. Patent No. 4,932,414 issued to Coleman et al. ("Coleman"). These rejections are respectfully traversed.

III. Rejection under 35 USC §103

Claims 1-6, 8, and 18-20 were rejected under 35 USC §103(a) as being unpatentable over Lin in view of Hossack, and further in view of Otsuka. Regarding this rejection, the Office Action indicates that Lin discloses an apparatus with a transducer for providing simultaneous viewing of an instrument in two ultrasound intersecting imaging planes, and an instrument path positioned with respect to the planes such that an instrument may be simultaneously viewed in both imaging planes. The instrument path is also indicated as being provided at an intersection that, at least partially, defines the intersection of the two imaging planes, such that

simultaneous viewing in the two imaging planes can be provided. The Office Action further indicates that Lin discloses a biplane image of the instrument in proximity thereto can be generated by processing the image provided by each of the imaging planes, and that a 3D orientation can be provided as a composite of two images. Lin is additionally indicated as disclosing a probe coupled to a display system which includes circuitry and a monitor for viewing single or biplane images generated by transducers.

The Office Action admits that Lin fails to explicitly disclose extraction of an estimation region used for estimating a motion of the object, and images from the transducer being two-dimensional and PZT elements array. Otsuka is relied upon for disclosing determination of velocity components of three-dimensional motion of an object, as well as a feature extraction unit that includes an intersection line histogram obtaining unit coupled to a velocity estimator, and an intersection line along tangent planes and motion trajectory. Hossack is relied upon for disclosing ultrasound transducers that are constructed of a piezoelectric material, as well as first and second transducer arrays that transmit ultrasonic waves to an object and acquire reflection signals. Hossack is additionally relied upon for disclosing multiple two-dimensional image data being accumulated and assembled into a three-dimensional volume, reconstructing three-dimensional images, and a motion estimator which receives image data from both transducer arrays in order to estimate/detect a three-dimensional motion of the object from the reflection signals. The Office Action concludes that it would have been obvious to combine the teachings of Lin with those of Hossack and Otsuka in order to arrive at the claimed invention. Applicants respectfully disagree.

As amended, independent claim 1 defines an ultrasonic motion detecting device that comprises:

> first and second ultrasonic transducers having piezoelectric elements arranged in an array, which transmit ultrasonic waves to an object and acquire reflection signals from the object;
>
> a motion detection unit that extracts a plurality of estimation regions which are used for estimating partial motions of the object from the reflection signals that are acquired by the first and second ultrasonic transducers, and detects a three-dimensional motion of the object within the estimation regions; and
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> an image display unit that displays the three-dimensional motion within the estimation regions,
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> wherein ultrasonic wave scanning surfaces due to the first and second ultrasonic transducers cross over each other, and
>
> wherein the motion detection unit detects projected components that are detected from a plurality of first two-dimensional cross-section images of the object which are obtained from the first ultrasonic transducer and a plurality of second two-dimensional cross-section images of the object which are obtained from the second ultrasonic transducer to produce velocity components of the three-dimensional motion of the object which is positioned on an intersection line of the first and second two-dimensional cross-section images, and constructs the three-dimensional motion on the basis of the first two-dimensional cross-section image, the second two-dimensional cross-section image and the projected components.

The ultrasonic motion detecting device of independent claim 1 includes first and second ultrasonic transducers having piezoelectric elements arranged in an array in order to transmit ultrasonic waves to an object and acquire reflection signals from the object. The device includes a motion detector unit which extracts a plurality of estimation regions that is used for estimating partial motions of the object from the reflection signals acquired by the first and second ultrasonic transducers, and detects a three-dimensional motion of the object within the estimation regions. An image display is also provided for displaying the three-dimensional motion within the

estimation regions. The ultrasonic motion detection device is configured such that ultrasonic wave scanning surfaces resulting from the first and second ultrasonic transducers cross over each other. Additionally, the motion detection unit detects projected components that are detected from a plurality of first-dimensional cross section images of the object obtained from the first ultrasonic transducer and the plurality of second two-dimensional cross section images of the object obtained from the second ultrasonic transducer. The motion detection unit subsequently produces velocity components of the three-dimensional motion of the object, which is positioned on an intersection line of the first and second two-dimensional cross section images, and further constructs the three-dimensional motion based on the first two-dimensional cross section image, the second two-dimensional cross section image, and the projected components.

According to independent claim 1, plural estimation regions are set to estimate the partial motions of the object in order to detect the shift and/or deformation of an inspection region within the object. The three-dimensional velocity components of the motion of the object which are positioned on the intersection line of the biplane images are obtained to estimate the motion, based on the velocity components of the motion of the object which are projected onto the biplanes. More particularly, biplane images which cross over each other are obtained with two ultrasonic transducers, and a plurality of estimation regions are set. A three-dimensional motion vector is then constructed based on two-dimensional vectors which are independent from each other, and which are obtained from the biplane images. Thus, the projective component of the motion of the object which is apart from the imaging region where the correlation is not taken can be detected by using the biplane image which is made up of two cross-section images. According to such

features it becomes possible to estimate the three-dimensional motion of the object. See paragraph [0066] of the published application. Additionally, the invention of independent claim 1 is capable of providing an ultrasonic motion detecting device which can addresses some of the problems associated with other devices. See paragraph [0016].

The Office Action alleges that the combination of cited references discloses all of the features recited in independent claim 1. Applicants' review of the cited references has revealed various differences from the claimed invention. Lin discloses an ultrasound imaging apparatus with biplane instrument guidance which provides simultaneous viewing of an instrument in two ultrasound imaging planes. An ultrasound imaging probe is provided to generate at least two ultrasound imaging planes, and an instrument path is positioned with respect to the planes such that an instrument may be simultaneously viewed in both imaging planes. Contrary to the assertions made in the Office Action, however, Lin only discloses an apparatus for ultrasound imaging with biplane instrument guidance, and does not disclose or suggest motion of a living body. Lin also appears to be silent on setting a plurality of estimation regions, and constructing a three-dimensional motion vector based on two-dimensional vectors which are independent from each other, and which are obtained from the biplane images.

Otsuka discloses a system for extracting image features from an image sequence in which frames are sequentially arranged with respect to time. The system includes a unit for inputting the image sequence, a unit for acquiring a motion trajectory of an image contour of a target included within a region in the input image sequence, a unit for acquiring a plane histogram of a tangent plane to the motion trajectory and partial planes which may be included in the motion directory, and a

unit for measuring temporal features of the image from the acquired plane histogram. According to Otsuka, however, three-dimensional volume data is obtained by forming difference images among the frames that are arranged in time sequence, in stacking the formed difference images.

Contrary to the assertions made in the Office Action, Otsuka does not disclose determination of velocity components of three dimensional motion of an object as set forth in independent claim 1. Although the cited passage discusses velocity components within spatiotemporal space region, the vectors disclosed by Otsuka are two dimensional vectors obtained in (x, y, t) space, which includes a time axis. See column 9, lines 1-30, and Figs. 4, 8, and 9. The cited passage does not describe "a three dimensional vector inspection." Otsuka indicates that directions of the intersection lines formed by mutually different and non-parallel tangent planes are all the same with respect to the motion trajectories of the moving objects which translate uniformly at equal velocities and to equal directions. Furthermore, the intersection lines have characteristics such that their direction match the moving directions of the moving objects within the spatiotemporal space. See column 10, lines 36-43. This disclosure assumes the existence of a plurality of objects in a plane, with each object moving as a solid body. As a result, it becomes possible only to detect one vector and to draw one movement track per object. Thus, it is not possible for Otsuka to detect "partial motions" of the object, as in the present invention. It is also not possible to detect the movement and/or deformation of an inspection region within the object. Otsuka appears to only disclose a technique for handling an image sequence for monitoring and detecting a target therein. In fact Otsuka does not even appear to be concerned with the detection and use of projected components with a biplane structure, as in the present invention.

Hossack discloses an ultrasonic probe which includes at least two ultrasonic arrays and allows construction of three-dimensional images of the region examined by the probe. Two dimensional images are sequentially obtained from each of an array 20 and array 22 by moving a probe having the arrays 20 and 22 in a moving (scanning) direction, as shown in Figs. 1-10. In general, the array 22 is used as an imaging array, so that the three dimensional images are formed by spatially arranging data of the array 22 in the moving direction. The array 20 is used as a tracking array and the array 20 detects a motion of the probe in the moving direction. As illustrated in Figs. 1-10, the array 20 and the array 22 never intersect. This is to be expected because the array 20 is used only for a function of the tracking plane. Thus, Hossack does not disclose and suggest an ultrasonic motion detecting device which detects the motion of the object, and in particular the partial motions of the object of the living body using the biplane images, and re-arranges a position to be treated.

It is therefore respectfully submitted that independent claim 1 is allowable over the art of record.

Claims 2-4, 6, 8-10, and 19 depend from independent claim 1, and are therefore believed allowable for at least the reasons set forth above with respect to independent claim 1. In addition, these claims each introduce novel elements that independently render them patentable over the art of record.

As amended, independent claim 18 defines an ultrasonic motion detecting device that comprises:

> first and second ultrasonic transducers, which transmit ultrasonic waves to an object and acquire reflection signals from the object; and

a motion detection unit that extracts a plurality of estimation regions which are used for estimating partial motions of the object from the reflection signals that are acquired by the first and second ultrasonic transducers, and detects a three-dimensional motion of the object within the estimation regions;

wherein ultrasonic wave scanning surfaces due to the first and second ultrasonic transducers cross over each other, and

wherein the motion detection unit detects velocity components of the three-dimensional motion of the object, which is positioned on an intersection line of the ultrasonic waves scanning surfaces, based first two-dimensional cross-section images of the object obtained from the first ultrasonic transducer in sequential frames and second two-dimensional cross-section images of the object obtained from the second ultrasonic transducer in sequential frames, and constructs the three-dimensional motion of the object to be displayed in an image display unit in accordance with the velocity components of the three-dimensional motion of the object.

According to some of the features of independent claim 18, the motion detection unit extracts a plurality of estimation regions which are used for estimating partial motions of the object from the reflection signals acquired by the first and second ultrasonic transducers. The motion detection unit also detects velocity components of the three-dimensional motion of the object within the estimation regions. This is done, in part, based on first two-dimensional cross section images of the object obtained from the first ultrasonic transducer in sequential frames, and second two-dimensional cross section images of the object obtained from the second ultrasonic transducer in sequential frames. The three-dimensional motion of the object is subsequently constructed to be displayed in an image display unit in accordance with the velocity components of the three-dimensional motion of the object. As previously discussed with respect to independent claim 1, the cited references fail to provide any disclosure or suggestion for such features.

It is therefore respectfully submitted that independent claim 18 is allowable over the art of record.

Claim 20 depends from independent claim 18, and is therefore believed allowable for at least the reasons set forth above with respect to independent claim 18. In addition, this claim introduces novel elements that independently render it patentable over the art of record.

IV. Conclusion

For the reasons stated above, it is respectfully submitted that all of the pending claims are now in condition for allowance. Therefore, the issuance of a Notice of Allowance is believed in order, and courteously solicited.

If the Examiner believes that there are any matters which can be resolved by way of either a personal or telephone interview, the Examiner is invited to contact Applicants' undersigned attorney at the number indicated below.

AUTHORIZATION

Applicants request any shortage or excess in fees in connection with the filing of this paper, including extension of time fees, and for which no other form of payment is offered, be charged or credited to Deposit Account No. 01-2135 (Case: 520.46263X00).

Respectfully submitted,
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